Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters	)	IB Docket No. 16-408
	)	
	)	

To: The Commission

COMMENTS OF LOCKHEED MARTIN CORPORATION

Lockheed Martin Corporation ("Lockheed Martin"), pursuant to Section 1.415 of the Commission's Rules, 47 C.F.R. § 1.415, hereby provides its comments in response to the Commission's Notice of Proposed Rulemaking in the above-captioned proceeding.[1] Lockheed Martin is appreciative of the effort the Commission is making to ensure that its regulations for non-geostationary satellite orbit ("non-GSO") system designs and deployments keep reasonable pace with the rapidly-developing state of the technology in this important new area – on fixed-satellite services ("FSS") including broadband services. Lockheed Martin's comments address several specific proposals the Commission advances in its *NPRM* and provide context for other emerging uses that should be taken into account in bands shared by non-GSO systems and non-satellite services.

Lockheed Martin is a manufacturer of, and provider of commercial launch services to, satellite systems, as well as ground systems, operating around the world, providing a variety of services in various frequency ranges, including the FSS frequencies that are implicated by the *NPRM*. Lockheed Martin is also a manufacturer of airborne platforms, capable of carrying payloads, operating across a range of frequency bands. In all of these capacities, Lockheed

[1] *Update to Parts 2 and 25 Concerning on-Geostationary, Fixed-Satellite Service Systems and Related Matters*, IB Docket No. 16-408, FCC 16-170 (rel. Dec. 15, 2016) ("*NPRM*").

Martin has a direct and substantial interest in this proceeding.

As an initial matter, Lockheed Martin supports the Commission's proposals to reinstate secondary FSS use in the specified frequency bands in the 20/30 GHz range.[2] Specifically, Lockheed Martin supports a secondary allocation to the FSS in the 17.8-18.3 GHz band and the incorporation of the international PFD limits into the Commission's rules to protect the Fixed Service. Lockheed Martin also supports non-GSO FSS systems to operate in the 18.3-18.6 and 19.7-20.2 GHz bands, subject to satisfying the downlink EPFD limits applicable internationally to protect GSO FSS networks. It agrees with the Commission that these proposals would codify existing practices, and thus provide greater regulatory certainty on matters already deemed consistent with the public interest. Further, Lockheed Martin supports both GSO and non-GSO FSS in the 19.3-19.4, 19.4-19.6, and 29.3-29.5 GHz bands as proposed by the Commission.[3] These proposals would provide a mechanism for making additional spectrum available for FSS use that would accommodate currently-pending system designs and enable new and creative designs yet to be presented.

Lockheed Martin also supports the Commission's proposal to expand and modify its rule regarding avoidance of in-line interference from non-GSO FSS systems to geostationary satellite orbit ("GSO") networks.[4] The expansion of frequency bands to which Section 25.261 of the Commission's Rules (47 C.F.R. § 25.261) applies is a superior alternative to the current procedure of automatically dividing spectrum on a frequency sub-band basis among processing round participants. It will enable more timely and efficient spectrum use and ensure the requisite protection of GSO FSS operations, while providing non-GSO operators with greater regulatory

---

[2] *NPRM*, FCC 16-170 at ¶¶ 9-14.

[3] *See NPRM*, FCC 16-170 at ¶ 13.

[4] *See NPRM*, FCC 16-170 at ¶ 23.

certainty. Lockheed Martin also supports the Commission's proposed companion clarification to Section 25.157 of the Commission's Rules (47 C.F.R. § 25.157) regarding the inapplicability of band-splitting procedures to applications granted on condition of compliance with the avoidance of in-line interference mechanism.[5]

On the related issue of ensuring the effectiveness of the Commission's mechanism for avoidance of in-line interference, Lockheed Martin supports the Commission's proposal to include additional non-GSO FSS bands in Section 25.271(e) of the Commission's Rules (47 C.F.R. § 25.271(e)), and to apply the requirement to operators of non-U.S.-licensed non-GSO FSS systems that are granted market access to the United States.[6] In this regard, the website maintained by each operator should specify the ephemeris data for each satellite in their constellations in the North American Aerospace Defense Command ("NORAD") two-line orbital element format. By requiring that ephemeris data for each satellite be presented in this format, the Commission helps facilitate the identification by affected operators (particularly in the GSO) of the source of unexpected interference from a non-GSO FSS system.[7] In Lockheed Martin's view, updating the ephemeris data every three days is generally sufficient, but the Commission should require updates within 12 hours, as one possible time frame, by operators of non-GSO FSS satellites with no station-keeping capability that have experienced significant orbital perturbations (*e.g.*, from solar events that reduce a satellite's altitude by more than one

---

[5] *Id.*

[6] *Id.*, at ¶ 24.

[7] To be useful in this regard, the Commission should ensure that the full ephemeris data from the NORAD two-line element format be included in the maintained website bulletin boards of proposed Section 25.271(e), as visibility of the major orbital elements (such as argument of perigee, right ascension of the ascending note, inclination, eccentricity, and so on) is required to make the obligation meaningful.

kilometer).[8] Lockheed Martin is of the further view that in order to share the spectrum with other emerging services (*e.g.*, airborne platforms of the type discussed below that operate in the fixed service), updates by operators of non-GSO FSS satellites with no station-keeping capability may need to be less than 12 hours (even where no orbital perturbations have been experienced). The exact frequency of such updates requires further study.

Next, Lockheed Martin supports the Commission's proposal to apply to non-GSO FSS earth stations the limitations on off-axis emissions, calculated in equivalent isotropically-radiated power ("e.i.r.p.") density, that apply to earth stations operating with space stations in the GSO.[9] The fixing of limits will allow a reduction in the required angular separation between co-frequency non-GSO FSS space station operations, and thus should facilitate sharing and technology neutrality, and preserve opportunities for later system entry.

Lockheed Martin agrees with the Commission's proposal to consider these e.i.r.p. density limits to be default limits, subject to certification as proposed; however, Lockheed Martin recommends that the Commission should allow the limits to be exceeded to the extent that an operator seeking to exceed them has coordinated with all other non-GSO FSS systems that are *both* authorized *and* operating in the same frequency band – as opposed to the Commission's proposal to allow exceedances upon coordination with the broader category of all authorized non-GSO FSS systems in the same frequency band. It may be difficult for an operator to coordinate with an authorized system operator that has not proceeded to the operational or near-operational stage, and such a difficulty should not be allowed to stop exceedances that are agreed to be not problematic among operational systems.[10] Requiring coordination only to the extent

[8] *See NPRM,* FCC 16-170 at ¶ 25.

[9] *Id.,* at ¶ 30.

[10] In this regard, the application of the coordination of exceedances exception to operators of authorized systems, rather than to all authorized systems, is consistent with actions the

that Lockheed Martin proposes represents a more flexible and pragmatic approach to allowing exceedances that reflects the significant complexity associated with non-GSO FSS systems under development today; it would also be consistent with recent precedent and avoid compromising its effectiveness.

On the subject of milestones for non-GSO FSS systems, the Commission, in an effort to afford operators greater flexibility in system design and implementation, proposes that an authorization holder that has launched and placed into operation 75 percent of its authorized non-GSO FSS space stations within six years of grant will have met the final milestone and earned the release of its final surety bond installment.[11] The Commission proceeds to inquire, however, if it should, as an alternative to a fixed percentage at the six-year point, require the launch and operation of a number of satellites specific to the services and constellation proposed – *e.g.*, in the form of an applicant-specified minimum number of satellites to provide the proposed service – and asks also if such an alternative should be limited to "large" non-GSO FSS constellations.[12]

Lockheed Martin supports adoption of the 75 percent approach in the Commission's primary proposal,[13] along with the nine-year post-bond milestone, as a pragmatic and non-Draconian mechanism for ensuring the achievement of the milestone system's objectives. Under

---

Commission took in its recent Part 25 review action. *See Comprehensive Review of Licensing and Operating Rules for Satellite Services,* Second Report and Order, 30 FCC Rcd 14713, 14757 (2015) (permitting exceedances of a limitation where exceedances are "coordinated with operators of authorized space stations …").

[11] *NPRM*, FCC 16-170, at ¶ 32. An operator that meets the 75 percent requirement by the milestone deadline would face a new deadline, nine years from grant, to have 100 percent of its authorized satellites in operation. Failure to meet this deadline would result in the automatic reduction of its authorized space stations to the number deployed at the end of the ninth year. *Id.*

[12] *Id.*, at ¶ 33.

[13] Lockheed Martin notes that the International Telecommunication Union is studying the issue of bringing into use of frequency assignments to non-GSO FSS satellite networks/systems under the context of WRC-19 agenda item 7. The United States is actively participating in the ITU studies, and we recognize that this NPRM has a singularly domestic regulatory focus.

this proposal, service would be provided and spectrum would not be warehoused.

In Lockheed Martin's view, this approach would be the default requirement, but applicants (and perhaps authorization holders) should have the flexibility to decide for themselves – and demonstrate to the Commission – that they would be able to provide a meaningful quality of service with a percentage of satellites lower than 75 percent.

Lockheed Martin supports a rule that is able to strike a meaningful balance between preserving the purpose of the final current non-GSO implementation milestone and not artificially constraining the development and implementation of innovative and evolving non-GSO FSS constellation designs. A future applicant for a three-satellite HEO non-GSO system may be able to start a viable service with two satellites, for instance. As another example, a future applicant for a 3,000-satellite system may be able to provide a viable service with 2,000 satellites. Service objectives and designs in each case, and in all cases in between, are necessarily ad hoc.[14] The Commission should include in its regulations the ability to allow each future applicant the opportunity to demonstrate – using whatever formulation it deems appropriate to meet this burden of demonstration – that an initial configuration of fewer than 75 percent of its proposed satellites will enable service to be provided. No constellation size limitation would be appropriate for this option, and putative operators should be able to invoke the option either in their applications/requests for authorization, or up to the date of the critical design review (through a post-grant license modification application).[15] The effect of the alternative would be that the percentage of satellites (or specific number of satellites and orbital

[14] Lockheed Martin notes that an increased ability to accommodate non-GSO system designs is the primary rationale of the Commission's proposal (which Lockheed Martin supports below) to eliminate the global coverage requirement from the Commission's Rules. *See id.*, at ¶ 35.

[15] At CDR, the licensee/authorization holder will have a clear idea, perhaps not available at time of filing its application, of how it can implement its service design concept with fewer than 75 percent of its authorized satellites.

planes) required to be implemented by the end of the sixth year after grant to maintain the system authorization and secure release of the final bond installment would be lower than 75 percent. If the full constellation does not get implemented by the end of the ninth year from grant, the consequence would be the same as under the Commission's proposed new post-bond milestone.[16] To discourage frivolous filings that burden the Commission, Lockheed Martin would be supportive of 50 percent of satellites, or of some combination of satellites and orbital planes, as the default alternative. This number, while potentially no less arbitrary than the 75 percent figure, along with the milestone date nine years post grant would have the salutary benefit of encouraging putative operators to apply initially for smaller systems that can make their business model close – thereby reducing the coordination burden for themselves and others.

As indicated above, Lockheed Martin supports the Commission's proposal to eliminate the geographic coverage requirement for non-GSO FSS systems.[17] This requirement may not be compatible with the service objectives of all non-GSO FSS systems, and Lockheed Martin supports providing operators with greater flexibility to design their systems to meet emerging market demands.

Finally, Lockheed Martin is glad to see the Commission recognize the importance of considering how non-GSO FSS systems will be able to share with non-satellite systems

[16] Some of the other questions the Commission asks in Paragraph 33 of the *NPRM* seem beyond the scope of the milestone issue. For example, the Commission asks if a license should be terminated automatically if the operator fails to maintain at least one operational satellite in orbit for a specified period of time. *Id.* Lockheed Martin's understanding is that Section 25.161(c) of the Commission's Rules (47 C.F.R. § 25.161(c)) would apply in the situation – at any point in the license term – where all operational satellites in an authorized non-GSO system were removed from operation (either physically or via a cessation of function), and would result after 90 days in the automatic termination of the authorization in the absence of a request for specific authority. Any new provision the Commission contemplates in response to its inquiry in the *NPRM* should not be inconsistent with Section 25.161(c).

[17] *NPRM*, FCC 16-170, at ¶ 35.

operating in the same bands.[18] Airborne platforms are an important emerging use, and enable a variety of new applications for a wide range of missions, such as communications and intelligence, surveillance, and reconnaissance ("ISR"). Communications systems operating on airborne platforms – keeping station at nominally fixed points relative to the ground – technically fall under the umbrella of terrestrial services – including the fixed service. Lockheed Martin notes that non-GSO system interference into traditional fixed services is generally resolvable, other than for some exceptional cases, because the geometry provides isolation between high elevation FSS links and low elevation fixed links. However, in the absence of technical sharing rules, non-GSO systems and airborne platforms have the potential for in-line interference events, whereas such events typically do not arise between traditional terrestrial fixed services and non-GSO operations.[19]

There are distinct regulatory solutions for different operating scenarios that the Commission should consider to promote sharing between nominally fixed airborne platforms[20] and non-GSO systems in the same band on the same frequencies.

One operational scenario is when co-frequency airborne platform communication links and FSS communication links operate in the same direction of transmission, there are potential in-line event interference issues for both the uplink and downlink paths. The operating characteristics of a nominally fixed airborne platform define a small control box in which

---

[18] *NPRM*, FCC 16-170, at ¶ 17.

[19] Lockheed Martin's comments about sharing mechanisms that should be considered for incorporation into Commission regulations or license conditions between non-GSO systems and airborne platforms operating in the Fixed Services would apply not only to the Ka-band frequencies specifically discussed in other portions of the NPRM but also to co-frequency operations in other bands, such as the Q- and V-bands. Whatever regulations the Commission adopts in this regard should apply in all bands where non-GSO systems and airborne platforms may both operate.

[20] Nominally fixed airborne platforms employ station-keeping to maintain the nadir below the platform within a relatively small radius, <10 km, of a fixed point on the ground.

airborne platforms can be found when at station. The regulatory solution would be to ensure the availability of detailed non-GSO ephemeris data that is regularly updated – this would allow in-line events to be addressed, while facilitating dynamic sharing, as discussed above. Substantially different from a non-GSO system that will have multiple and redundant link paths to users, ground communication links with airborne platforms will typically communicate with only a single in-view platform (much as a fixed user terminal communicates with a specific fixed base station or other fixed user terminal). As a result, a spectrum sharing mechanism accommodating when there are in-line events between airborne platforms and non-GSO satellites would be required to permit greater use of the bands that non-GSO FSS and fixed services both occupy.

A second operational scenario is when airborne platforms communicating with ground terminals transmit in the opposite direction of non-GSO system transmissions; for example, when airborne platform air-to-ground transmissions are on the same frequencies as non-GSO Earth-to-space transmissions or, conversely, airborne platform ground-to-air links are on the same frequencies as non-GSO space-to-Earth transmissions. There will be the need in connection with this method for the Commission to address technically any cases where non-GSO Earth-to-space transmissions might harmfully interfere with ground terminals receiving air-to-ground transmissions and likewise where airborne platform ground station transmitters may cause harmful interference with non-GSO system earth station receivers. To address these potential instances of harmful interference, the Commission should consider requiring that non-GSO terminals operate at a high elevation angle (bidirectional) and airborne platform ground terminals[21] operate at a minimum 15 degree elevation angle (bi-directional). Additionally,

[21] Similar to the need recognized by the Commission for blanket authorizations for non-GSO FSS terminals, ground terminals for airborne platforms should be eligible for blanket authorizations to facilitate a large user populations for communication services offered over such platforms.

further study will be necessary to determine the operating parameters, such as a minimum spatial separation distance required, between non-GSO ground stations and airborne platform user terminals.[22]

Conclusion

Lockheed Martin applauds the Commission for its proposals in the *NPRM*. It urges the Commission to proceed with the implementation of the proposals, while taking into account the comments and suggestions that Lockheed Martin respectfully put forth in the foregoing Comments. Lockheed Martin also appreciates the opportunity to offer comments on emerging uses in bands shared with non-GSO systems and identify a means to promote additional spectrum sharing.

Respectfully submitted,

LOCKHEED MARTIN CORPORATION

By: *Jennifer A. Warren*

Jennifer A. Warren
Vice President, Technology Policy & Regulation
Trade & Regulatory Affairs
Lockheed Martin Government Affairs
2121 Crystal Drive #100
Arlington, VA 22202

February 27, 2017

[22] Lockheed Martin notes that in Appendix C, the Commission is proposing to incorporate the Ka-band plan into the U.S. Table of Frequency Allocations. This would involve, among other things, removing the FS allocation in the 28.35-29.1 and 29.25-29.5 GHz frequency bands. Lockheed Martin continues to study that proposal and offers no comment at this time other than that the potential for co-primary use of these bands by airborne platforms under the sharing scenario described generally in these comments should be preserved, which would require the Fixed Service allocation to remain, at least for this limited type of operation.